BARBER COLMAN COMPANY

Models 271P and 272P
Capacitrols

INSTRUCTION MANUAL

GENERAL ELECTRIC
INSTRUMENTATION & COMMUNICATION
1200 KONA DRIVE
COMPTON, CA 90220
(213) 642-5317

All 270 and 470 Series Controllers are shipped with an Adjustable Line Compensator on the rear panel. 0–15 ohm Compensators are standard, and others are optional.

ADJUST THE LINE COMPENSATING RESISTOR TO EQUAL THE DIFFERENCE IN RESISTANCE BETWEEN THE LEAD WIRE RESISTANCE AND THE MAXIMUM RESISTANCE OF THE ADJUSTABLE LINE COMPENSATOR.

For Example:

Lead wire resistance is measured to be 5 ohms.

Maximum resistance of the Adjustable Line Compensator is 15 ohms (standard). Set the Line Compensator for 10 ohms.

For best results, now measure the total resistance across the series resistance of the leadwires and the line Compensator – it should be exactly 15 ohms.

For Example:

Lead wire resistance is measured to be 17 ohms.

Maximum resistance of the Adjustable Line Compensator is 30 ohms. Set the Line Compensator for 13 ohms.

For best results, now measure the total resistance across the series resistance of the leadwires and the Line Compensator – it should be exactly 30 ohms.

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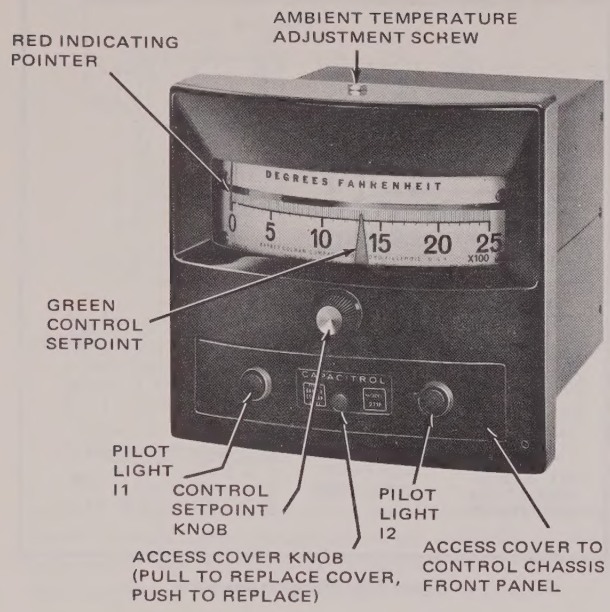


Figure 1-1. 270 Series Controller

1. DESCRIPTION

1.1 General

The Series 270 is an indicating millivoltmeter controller designed to accept the output of either a Barber-Colman thermocouple, radiation detector, or millivolt source.

Forty-five standard scale ranges are available for the five inch scale. Temperature indication is by a red upper pointer of the meter. Since the thermocouple input is directly to the meter without any electronic amplification, the meter will indicate a process temperature during a complete power failure. Setpoint temperature is selectable by turning the front panel knob to position a green bottom pointer until it is at the desired setpoint temperature.

Located behind the lower front panel door are the tamper-proof control adjustments.

For a radiation detector input specify special 19. Consult a Barber-Colman Sales Engineer for inputs from pressure transducers and resistance bulbs.

1.2 Specifications

Minimum Input Span — 9 mVdc. Any Barber-Colman thermocouple or millivolt source. Cold junction and copper coefficient compensation is standard with thermocouple inputs in the range from 40°F to 130°F.

Temperature Indication — Red process variable pointer indicates temperature in degrees on a five inch temperature scale, which has an anti-parallax mirror.

Control Setpoint Temperature — Control setpoint temperature selected by adjusting a front panel knob to position a vertical green pointer until it coincides with the desired setpoint on the scale.

Relay Switching Output Ratings (271P) — Resistive Loads: 10A at 120 Vac; 5A at 240 Vac. Inductive Loads: 5A at 120 Vac; 2.5A at 240 Vac.

Relay Switching Output Ratings (272P) — Resistive Loads: 5A at 120 Vac; 2.5A at 240 Vac. Inductive Loads: 2.5A at 120 Vac; 1.25A at 240 Vac.

Cycle Time (272P) — Tamper-proof internal front panel adjustment. Adjustable from 3 to 30 seconds.

Proportioning Band (272P) — 2% of full scale. Not adjustable.

Reset — Tamper-proof internal front panel adjustment. Adjustable to eliminate offset at control point.

Thermocouple Break Protection — Heating off with an open thermocouple.

Ambient Temperature — Operating: +40°F to +130°F. Storing: -40°F to +150°F.

Sensitivity — 90 microamperes nominal for full scale deflection.

Accuracy — ±1% of full scale.

Multi-Voltage Capability — 120 or 240 Vac.

Power Consumption — 9 VA at 120 or 240 Vac, 50 or 60 Hz.

Shipping Weight — 12 pounds.

2. INSTALLATION

2.1 After Unpacking

This instrument has been manufactured carefully, inspected, and packed at the factory. Check the contents of the shipping container against the packing slip. If the equipment is damaged in transit, report the extent of the damage to the carrier immediately. Repack in the original box until ready for installation. Any instructions given on tags attached to the instrument should be followed carefully and then the tags should be removed. Handle with care.

2.2 Mounting

See Figures 2-1 and 2-2. Locate the instrument to avoid excessive dust or oil accumulations, and moisture. The ambient temperature should be within 40°F to 130°F. Avoid furnace walls and other sources of radiant heat.

2.3 Power Wiring

Power consumption is 9 VA at 120 or 240 Vac, 50 or 60 Hz. Power connections are made to the rear panel of the case. Do not ground the "GND" terminal to a neutral a-c line. Ground only to an adequate ground. Install a 1/8 ampere slow-blow fuse in the power line to the instrument.

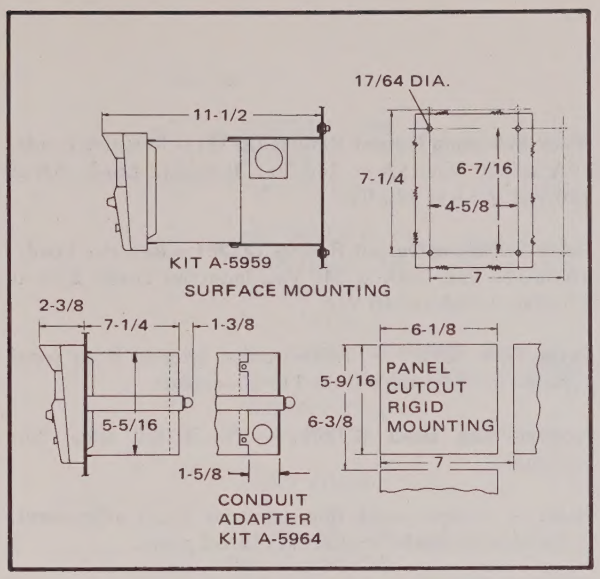


Figure 2-1. Rigid Mounting

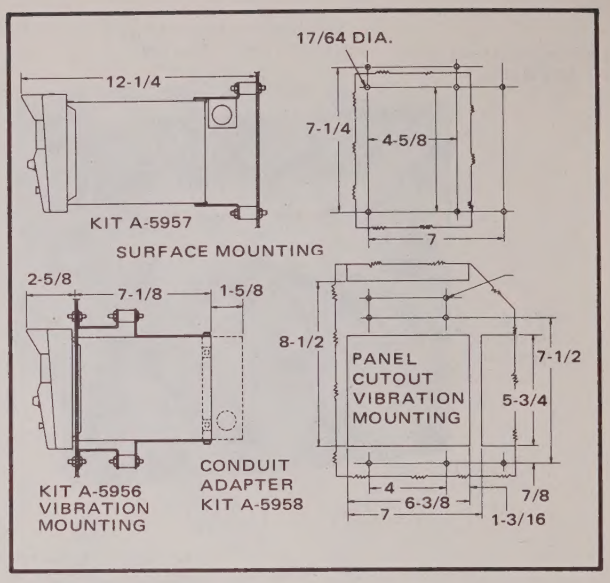


Figure 2-2. Vibration Mounting

2.4 Input Wiring

Do not place power wiring and thermocouple wiring in the same conduit or wiring trough. The wires from several thermocouples may be in the same conduit or wiring trough.

If shielded thermocouple leads are used, the shields should be insulated electrically and terminated at one location, preferably the housing ground of the Series 270.

When the Series 270 is ordered, the type of thermocouple desired is specified. The Barber-Colman Thermocouple Catalog lists a complete selection of thermocouple assemblies and thermocouple extension leadwire. Thermocouples should never be wired to the Series 270 with ordinary copper wire. Wire only with thermocouple extension leadwire such as that specified in the Barber-Colman Catalog.

Observe the correct thermocouple and thermocouple extension wire polarity. The negative wire of the extension wire is usually coded red.

2.5 Adjustable Line Compensator

All 270 Series Controllers are shipped with an Adjustable Line Compensator on the rear of the chassis panel. 0–15 ohm Compensators are standard, and others are optional.

ADJUST THE LINE COMPENSATING RESISTOR TO EQUAL THE DIFFERENCE IN RESISTANCE BETWEEN THE LEAD WIRE RESISTANCE AND THE MAXIMUM RESISTANCE OF THE ADJUSTABLE LINE COMPENSATOR.

For example:

Lead wire resistance is measured to be 5 ohms.

Maximum resistance of the Adjustable Line Compensator is 15 ohms (standard). Set the Line Compensator for 10 ohms.

For best results, now measure the total resistance across the series resistance of the leadwires and the Line Compensator – it should be exactly 15 ohms.

Lead wire resistance is measured to be 17 ohms.

For example:

Maximum resistance of the Adjustable Line Compensator is 30 ohms. Set the Line Compensator for 13 ohms.

For best results, now measure the total resistance across the series resistance of the leadwires and the Line Compensator – it should be exactly 30 ohms.

2.6 Thermocouple Break Protection

Figure 2-3 shows the recommended wiring. This wiring must be done after installation.

When TCB is connected a slight error may be introduced into the measuring system. With the instrument powered, and with the thermocouple maintained at a steady temperature, disconnect one of the TCB leadwires and see if there is any slight meter indicator movement. If there is, record the final scale position of the meter indicator and then reconnect the TCB lead. Next, adjust the Ambient Temperature Adjustment screw on the top of the meter housing until the meter indicator is at the same position it was when the TCB was disconnected.

2.7 Control Wiring

Typical External Wiring is shown on Figure 2-4.

3. OPERATION

The meter should read ambient temperature with the thermocouple and thermocouple break wiring disconnected. If it does not, adjust the Ambient Temperature Adjustment screw on top of the front cover.

The setpoint temperature is selected by adjusting a front panel knob to position a vertical green pointer until it coincides with the desired setpoint on the scale.

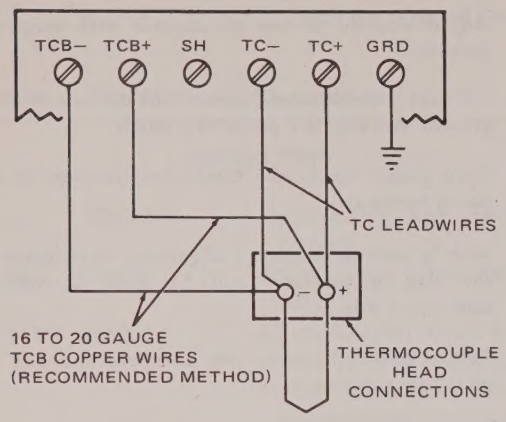


Figure 2-3. Method of Thermocouple Break Protection

Located behind the lower front panel cover are tamper-proof controls. Ignore descriptions not applicable to your instrument. The access cover is removed by pulling the small knob located below the control setpoint knob.

RESET Control (on all models) – Turning the RESET control counterclockwise will shift the meter indicator to the left. With a small screwdriver, turn the RESET control to the midpoint of its range. If the red temperature pointer does not coincide with the green setpoint pointer after the controlled load becomes thermally stable, an adjustment should be made. For the 272P, which has time proportioning control, turn the CYCLE TIME control fully counterclockwise to its minimum cycle time. An adjustment is then made with the RESET control, turning it in small increments with sufficient time allowed after each adjustment to permit the controlled load to become thermally stable. The proper reset adjustment occurs when the red meter temperature pointer coincides with the green setpoint pointer when the load is thermally stable.

CYCLE TIME Control (on Model 272P) – Models with time proportioning control are provided with a Cycle Time control for varying the relay switching rate from 3 (at CCW) to more than 30 (at CW) seconds per cycle. The faster cycle rates provide better control of loads with fast response times and little lag time. However, a relatively faster cycle time causes added wear on the chassis relays and any external contactors.

4. CIRCUIT DESCRIPTION

4.1 General

Refer to Figures 6-3 and 6-4, which are the overall schematics. Most of the electrical components shown on Figures 6-2 and 6-3 are on the printed circuit board located on the bottom of the chassis. The exceptions are the components listed in Table 6-2.

4.2 Connections

4.2.1 Thermocouple

Refer to the lower left part of Figure 6-2. The incoming signal from the thermocouple on the rear panel terminals marked TC+ and TC– goes without amplification to drive the meter.

CONTROL WIRING

Terminals 1, 2 and 3 are the relay contact connections
Terminal 1 is the normally closed contact
Terminal2 is the common
Terminal 3 is the normally open contact

Model 271P Relay Switching Output Ratings:
Resistance Loads: 10A at 120 Vac; 5A at 240 Vac
Inductive Loads: 5A at 120 Vac; 2.5A at 240 Vac

Model 272P Relay Switching Output Ratings:
Resistance Loads: 5A at 120 Vac; 2.5A at 240 Vac
Inductive Loads: 2.5A at 120 Vac; 1.25A at 240 Vac

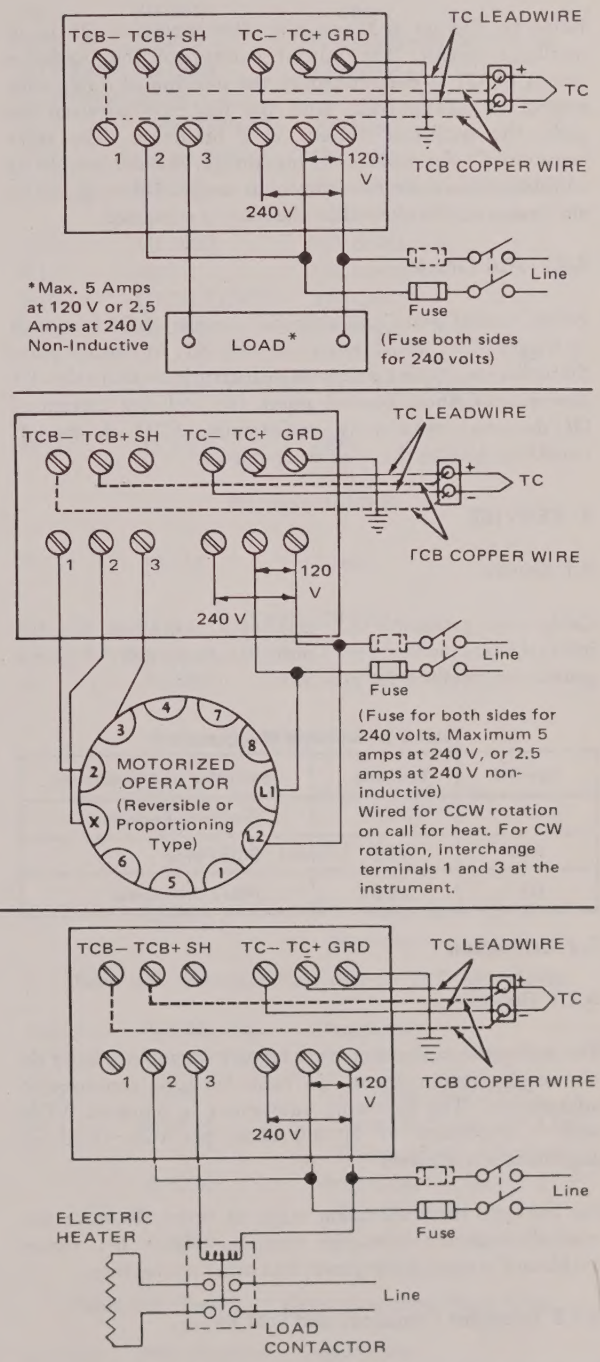

TCB– TCB+ SH TC– TC+ GRD
TC LEADWIRE
TC
TCB COPPER WIRE
1 2 3
120 V
240 V
*Max. 5 Amps at 120 V or 2.5 Amps at 240 V Non-Inductive
LOAD*
Line
Fuse
(Fuse both sides for 240 volts)
MOTORIZED OPERATOR
(Reversible or Proportioning Type)
(Fuse for both sides for 240 volts. Maximum 5 amps at 240 V, or 2.5 amps at 240 V non-inductive)
Wired for CCW rotation on call for heat. For CW rotation, interchange terminals 1 and 3 at the instrument.
ELECTRIC HEATER
LOAD CONTACTOR

Figure 2-4. Typical External Wiring Diagrams

4.2.2 TCB

The small direct current voltage placed in the thermocouple circuit through wiring between rear panel terminals (Figure 2-4) provides break protection. Should the thermocouple circuit open, the small voltage drives the meter

indicator upscale, causing the relay of the controller to drop out. The controller will operate normally without TCB protection.

4.3 Printed Circuit Board

4.3.1 Oscillator Circuit

Refer to Figures 6-3 and 6-4. The circuit of Q1 is an oscillator circuit. The output current of the oscillator circuit of Q1 is determined by the position of a flag with respect to pickup coils. With the flag fully between the coils, the oscillator current is a minimum. The reset capacitor C1 determines the bias on Q1. A small amount of additional transistor bias current is supplied through R2 to eliminate relay chatter when the relay is energized.

4.3.2 SCR Circuit

Below control point, the collector current of Q1 is enough to trigger SCR1 which energizes relay K1. At control point the collector current decreases sufficiently so that relay K1 de-energizes. Above control point, the collector current of Q1 decreases even more, maintaining SCR1 in the off condition, leaving the relay de-energized.

5. SERVICE

5.1 General

Calibration paragraph 5.2 outlines a procedure for the internal adjustments of the Controller. Paragraph 5.3 gives a general troubleshooting procedure.

Table 5-1. Summary of Adjustments

Symbol	Location	Description of Adjustments
L1	PCB	Oscillator Frequency
R10	PCB	SCR Firing
R2	PCB	Relay Differential

5.2 Calibration

5.2.1 General

The calibration adjustments are factory set and normally do not require readjustment. See Table 5-1 for a summary of adjustments. The following equipment is required. VOM with a sensitivity of 20,000 ohms per volt. Insulated alignment screwdrivers.

Go through the calibration steps in order. Remove the controller chassis from its housing. Figure 6-1 shows backboard terminals for power and other connections.

5.2.2 Oscillator Frequency and SCR Firing

Proceed as follows:

1. Turn the slug of the Oscillator Coil L1 until it is flush with the top of its coil.
2. Turn R2 to mid-position.
3. Turn the TEMP. RESET control C1 to mid-position.
4. Adjust setpoint pointer to coincide with temperature pointer.
5. Connect the voltmeter between the cathode of D1 and ground with negative probe to ground.
6. Turn power on to the Controller (connect to back-board terminals).
7. With a suitable insulated alignment screwdriver turn the slug of oscillator coil L1 until the voltmeter indicates 4 Vdc.
8. Adjust R10 until relay just energizes and left (red) pilot light turns on.

5.2.3 Relay Differential Adjustment

Potentiometer R2 on the printed circuit board determines the operating differential of relay K1. R2 is factory set to require .010 inch motion of the green setpoint pointer to cause control action to change from on to off. Turn R2 CW to widen the differential; turn R2 CCW to narrow the differential. Too narrow a differential (less than .010 inch motion of the relay) may cause relay chatter.

5.3 Troubleshooting

Be certain the Controller is at fault before going through a lengthy and perhaps unnecessary troubleshooting procedure. Check the operation of other instruments in the system.

Look for loose wires. Be certain all plug-in boards and pins are firmly seated.

Do not attempt to make major repairs on the PC Board. Minor repairs such as replacing broken pins may be made. When making repairs on printed circuit boards or soldering transistor or integrated circuit terminals, use a 35 watt or less soldering iron and 63/37 or 60/40 resin core solder.

In any continuity tests with the ohmmeter, be certain all power is removed from the Controller. Do not use the lower ranges of an ohmmeter since the internal battery in the ohmmeter may cause excessive current drain through transistors. If the Hewlett-Packard Model 427A Multi-Function Meter is available, use it for continuity tests because of the lower current drain of its ohmmeter. Do not apply too much pressure to the printed circuit board pins.

Diodes and transistors when they fail usually short circuit. The following applies to diodes and to transistors measured Collector to Base or Base to Emitter. If an ohmmeter reads zero ohm in both cases when its probes are reversed across a component, the component is shorted. An ohmmeter indicating a high resistance in one direction will usually mean that the component is good. A reading of infinite resistance in both cases means that the component is open and defective.

5.4 Service Information

For any service information please call either your local Industrial Instruments Division office or the sales office at Rockford. A phone call may save unnecessary attempts at repair.

Table 6-1. Printed Circuit Board Parts List for Both Models

Symbol	Part Number	Description
	CAPACITORS	
C1	39-372-3	Variable 2 to 13 pF (RESET control)
C2,4,12	39-415	250 pF ±20%, 500 WVDC, NPO
C3(271P)	39-087	62 pF, 5%, 500 WVDC [in some cases C3 is changed to 75 pF (part number 39-125) to obtain the proper adjustment of the circuit of Q1].
C3(272P)	39-376	47 pF, 5%, 500 WVDC
C5,15	39-417	.01μF GMV, 1000 WVDC
C6,7,11	39-153	50μF, +150 -10%, 50 WVDC
C8	39-015-1	25 pF, 5%, 600 WVDC
C9	39-260	56μF, 20%, 15 WVDC
C10	39-196	.22μF ±20%, 100 WVDC
C14	CYZR-770	2μF, +50 -20%, 100 WVDC
	DIODES	
D1	37-93	Zener, 12V, 400 mW ±10%
D2,3,5, 6,7	EYZP-384	60 P.I.V., 100 mA
D4	37-060	Variable Voltage Cap. Diode 33 pF at 4 Vdc
D8	37-148	100 P.I.V., 100 mA
	RELAY	
K1	A-7325	325Ω; pulls in at 10V max.
	INDUCTANCES	
L1	41-130	Variable, 2.7μH maximum, 1.2μH minimum
L2	41-136	Choke, 43μH ±10%, fo = 13.5 M Hz mininum
	TRANSISTOR	
Q1	EYZP-623	2N4126 PNP, Silicon
	RESISTORS	
Resistors are ± 10% tolerance, ½W, unless stated otherwise.		
R1	CYZR-170-4	6.8k ohms
R2	29-354	Potentiometer, 2.5k ohms ±30%, 1/4 W
R3	CYZR-170-1	22k ohms
R4	40-077	270 ohms
R5	CYZR-133-2	1.5k ohms
R6	CYZR-170-47	330 ohms
R7	CYZR-170-10	120k ohms
R8	CYZR-170-38	5.6k ohms
R9	40-094	22 ohms
R10	29-256	Potentiometer, 250 ohms
R11(271P)	40-1940	470 ohms, 1/4 W
R11(272P)	40-267	220 ohms, 1 W
R12	CYZR-170-43	220 ohms
R13	CYZR-170-41	1M ohms
R14	29-396	Potentiometer, 5M ohms (CYCLE TIME control)
R15	40-1693	33k ohms, 5%
R16	40-9-1	10k ohms, 5%
R18	CYZR-170-32	470 ohms
R19	40-1940	470 ohms, 1/4 W
	SILICON CONTROLLED RECTIFIER	
SCR1	37-94	C6F
	TRANSFORMER	
T1	30-317	Power
	CONNECTOR	
–	A-6338	Meter Plug Assembly
	SOCKET*	
–	34-748	Pilot Light Socket
	LAMPS	
I1,I2	36-034	14V Incandescent, .12 mA maximum

Table 6-2. Electrical Parts Not On PCB Assemblies

Symbol	Part Number	Description
C13	39-98	1μF ±20%, 250 WVDC
R17	A-9525	Adjustable 0–15 ohm Line Compensator (Standard)
	A-9755	Adjustable 0–30 ohm Line Compensator
	A-9756	Adjustable 0–50 ohm Line Compensator

Table 6-3. Parts List, Other Complete Assemblies

Symbol	Part Number	Description
	A-9201	271P Indicator-Chassis (includes A-9186 Indicator and A-7510 Chassis)
	A-9200	272P Indicator-Chassis (includes A-9186 Indicator and A-7296 Chassis)
	A-9083	Mounting Kit included with replacement Chassis

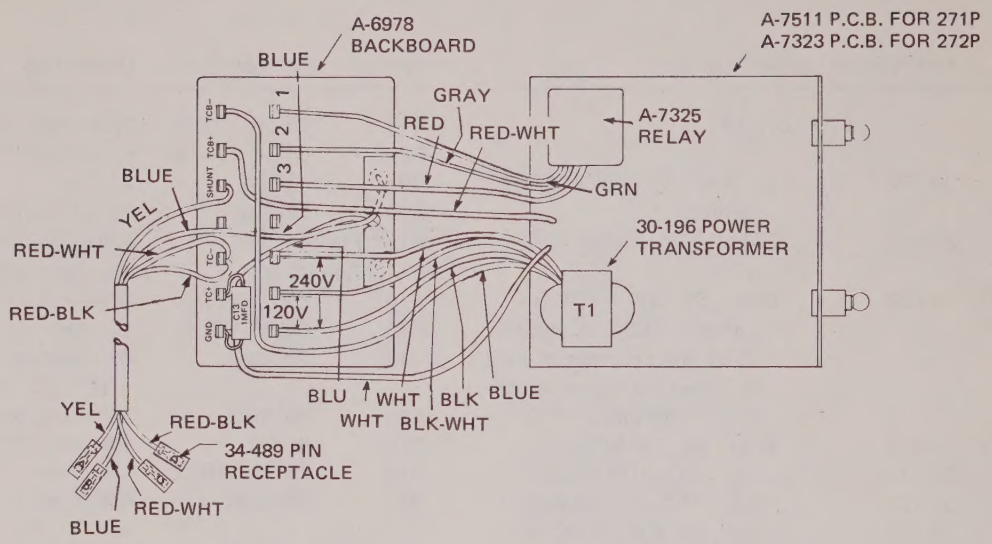


Figure 6-1. Wiring Diagram, Models 271P and 272P

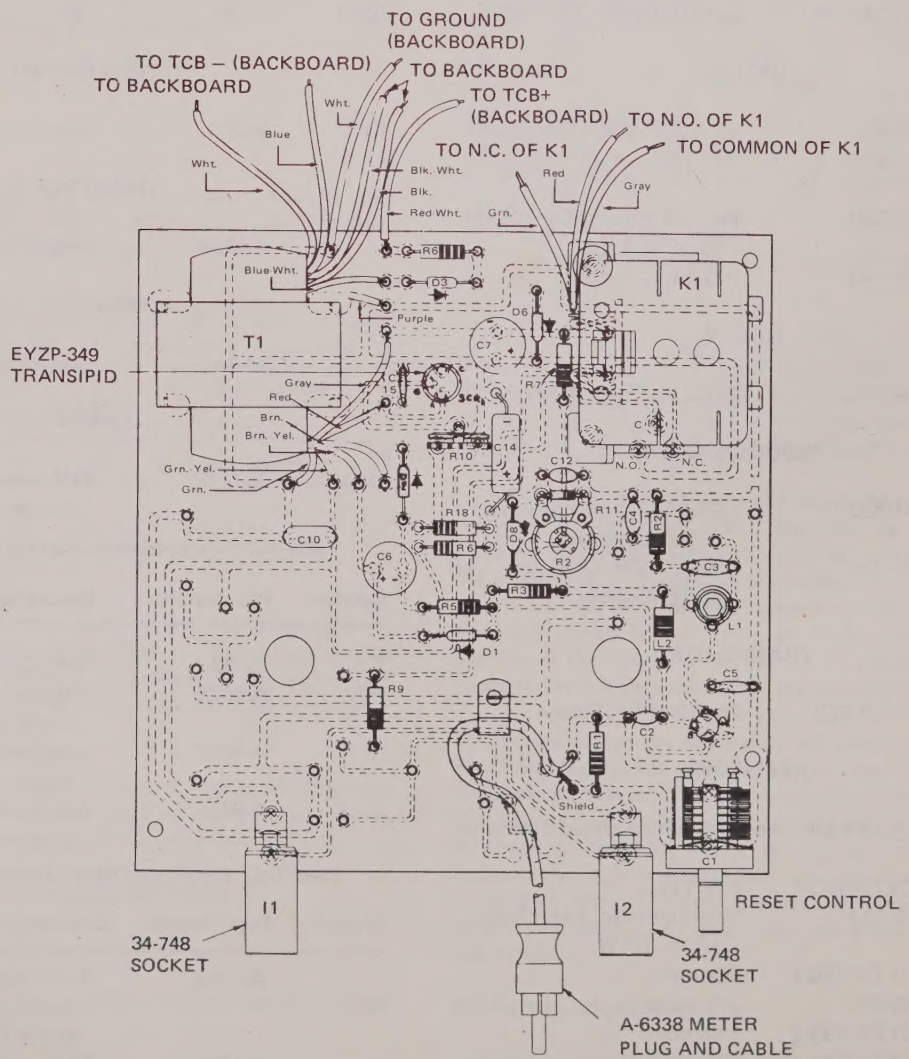


Figure 6-2. Model 271P Printed Circuit Board A-7511 Parts Location

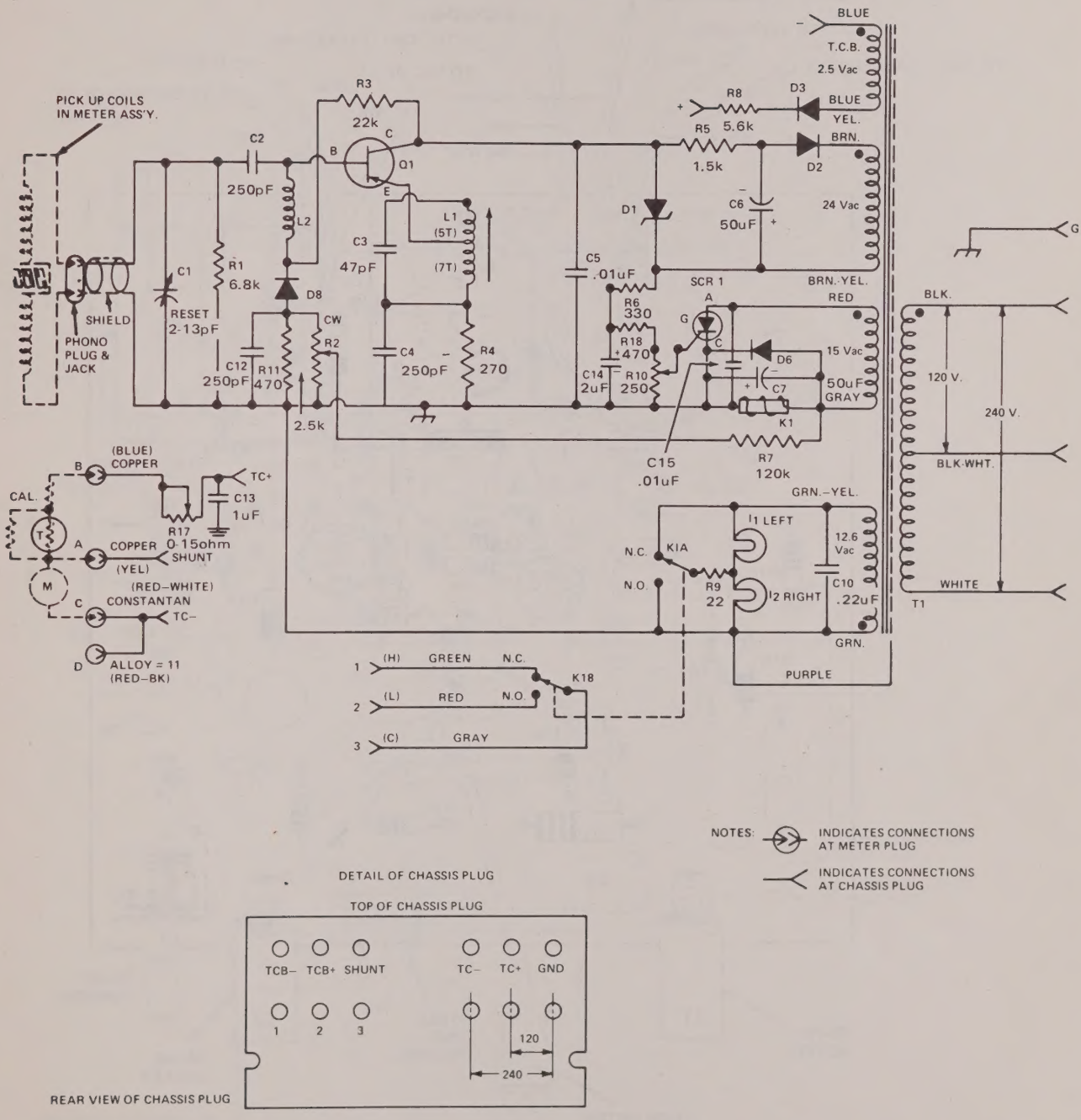


Figure 6-3. Model 271P Schematic

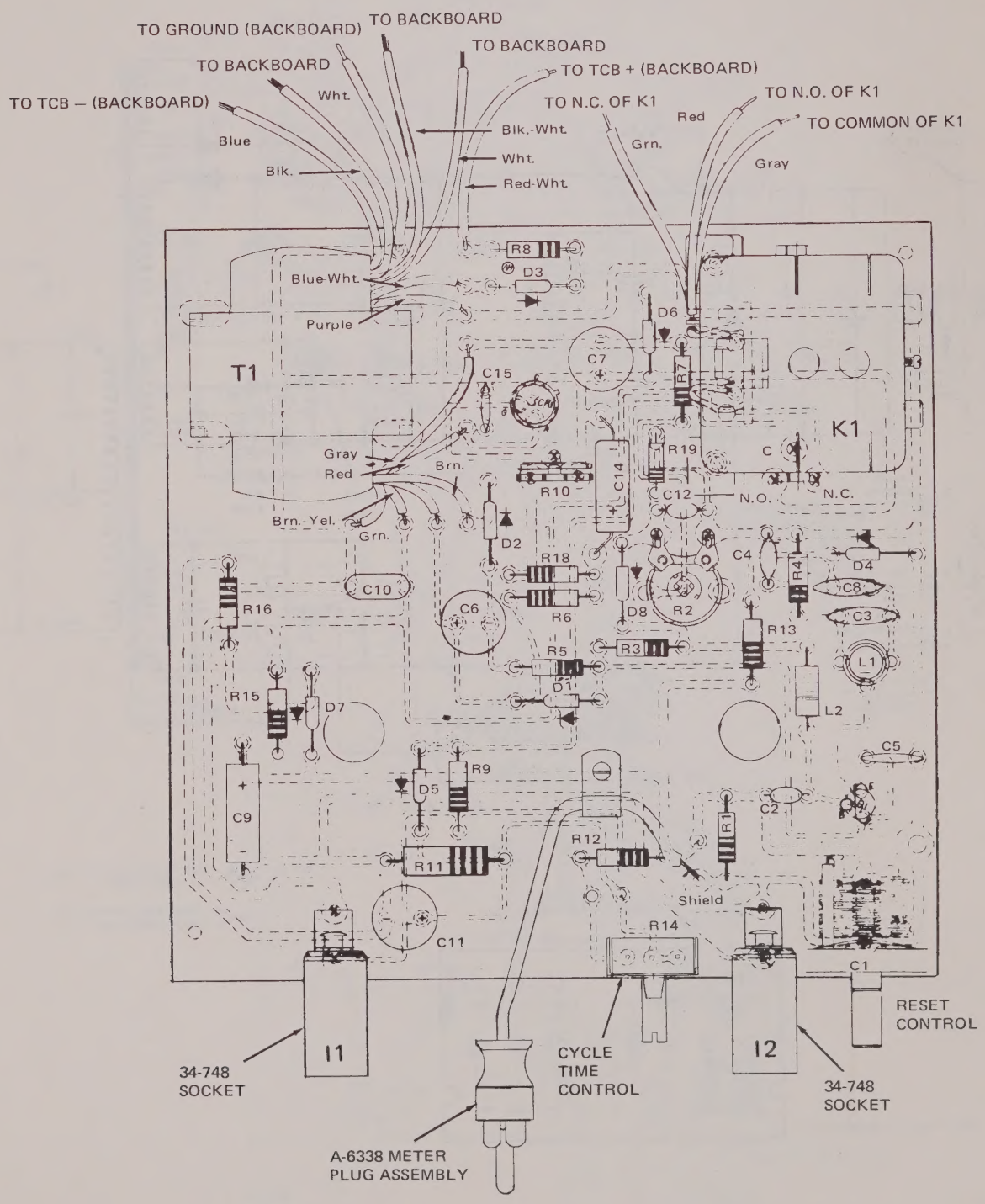
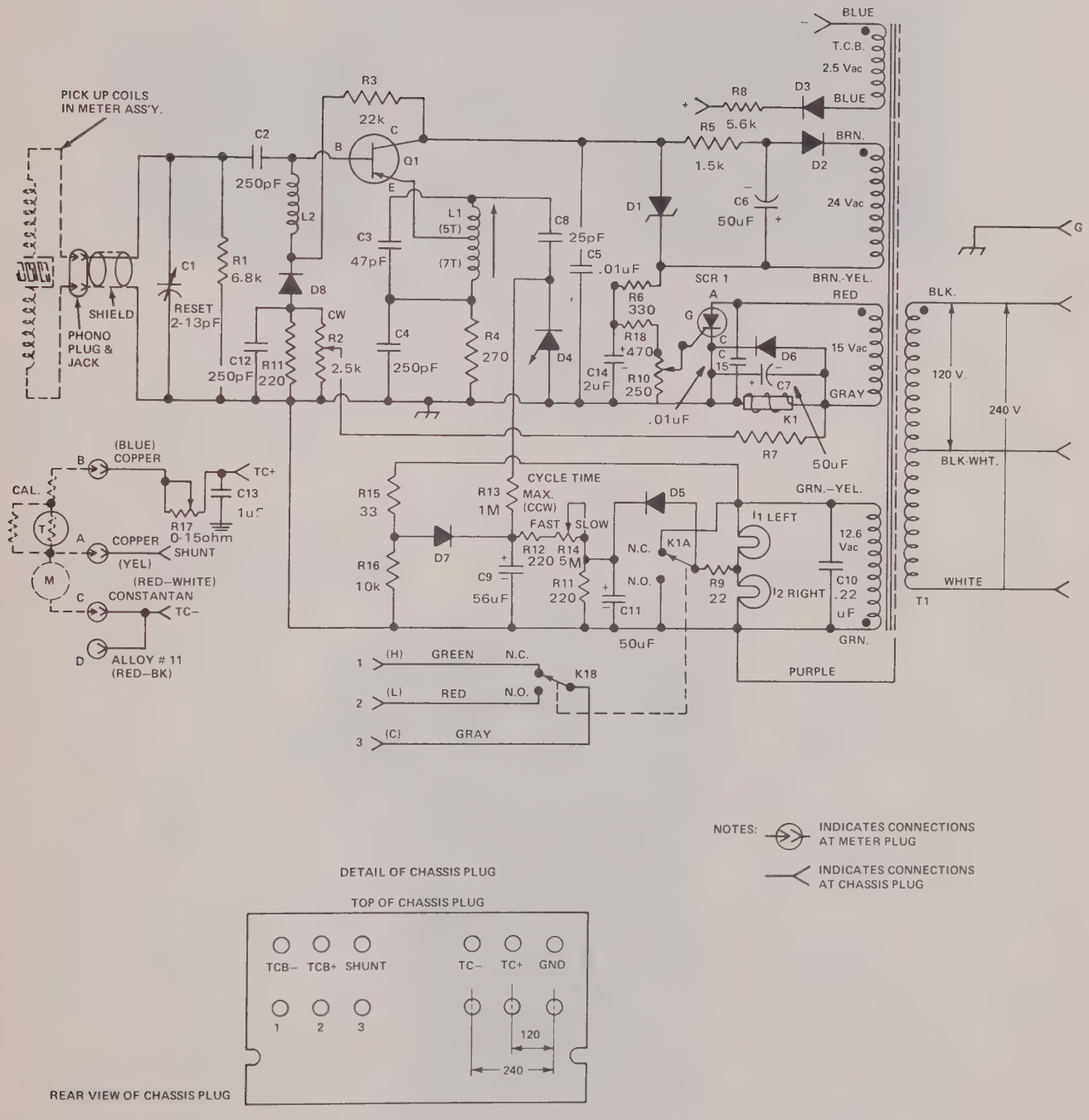


Figure 6-4. Model 272P Printed Circuit Board A-7523 Parts Location



NOTES: INDICATES CONNECTIONS AT METER PLUG

INDICATES CONNECTIONS AT CHASSIS PLUG

DETAIL OF CHASSIS PLUG

TOP OF CHASSIS PLUG

REAR VIEW OF CHASSIS PLUG

Figure 6-5. Model 272P Schematic

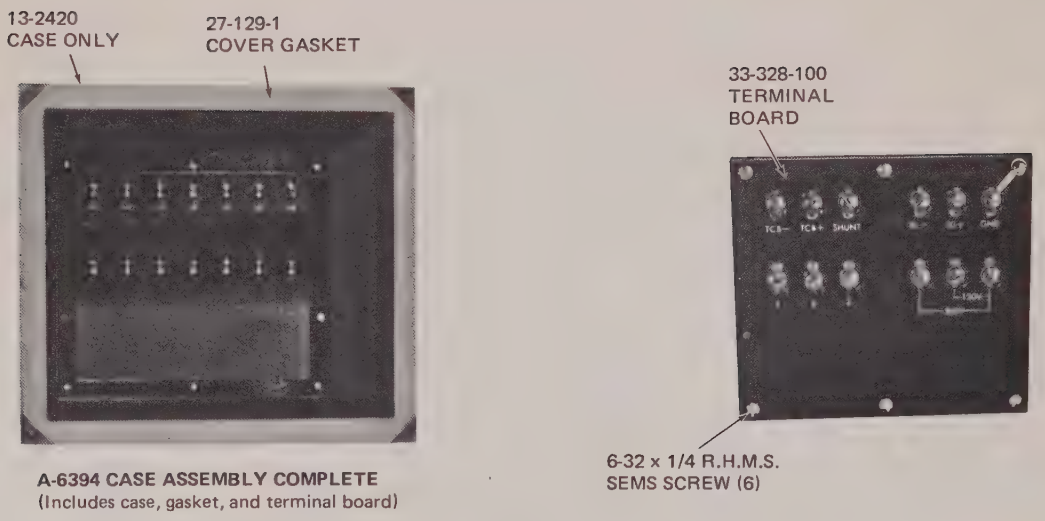


Figure 6-6. Replaceable Parts, Case Assembly A-6394

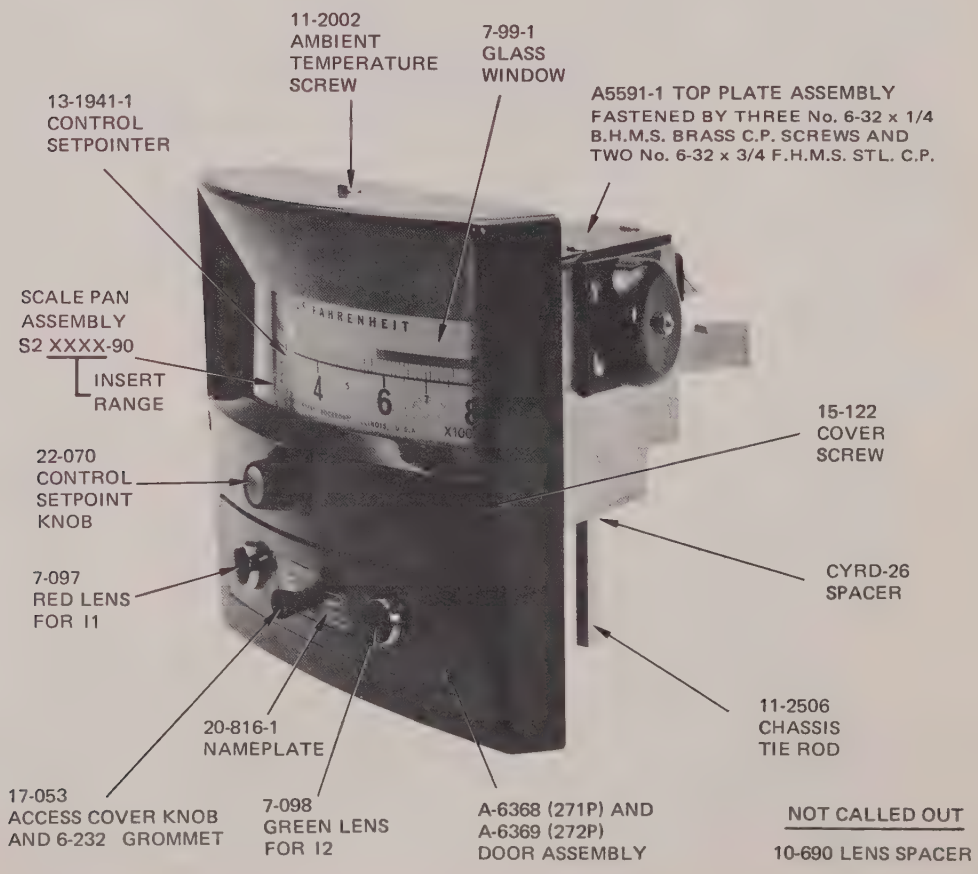


Figure 6-7. Replaceable Parts, Indicator Assembly A-9186, Front View

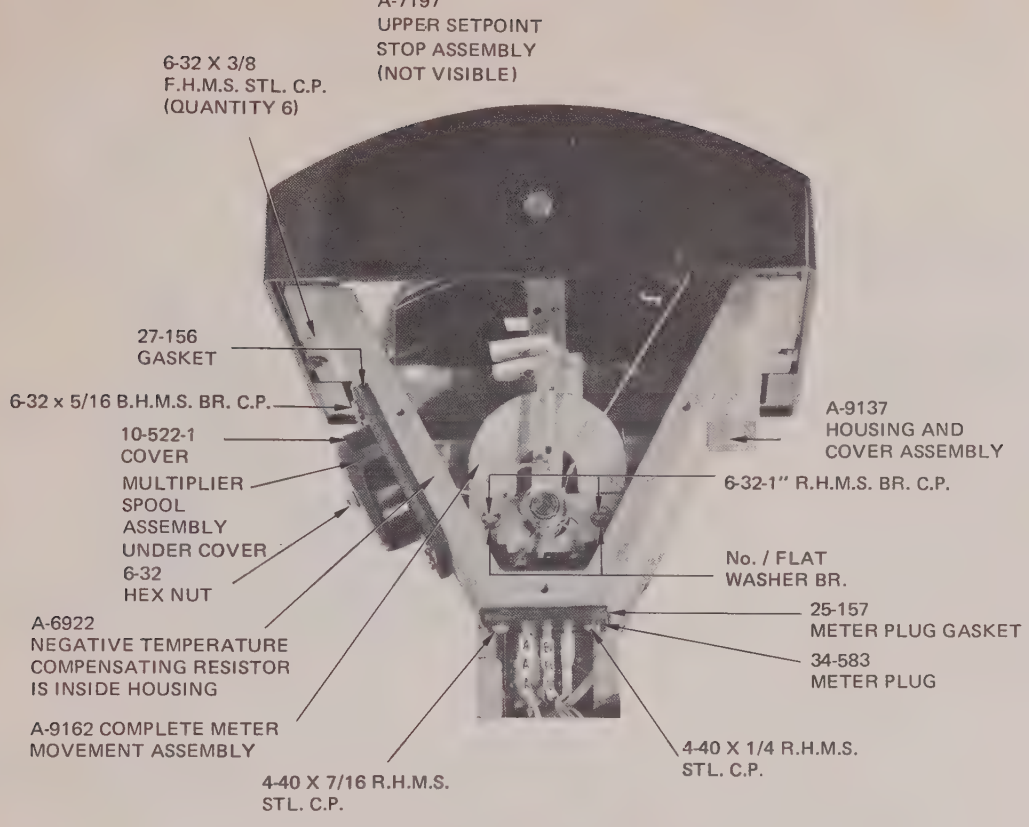


Figure 6-8. Replaceable Parts, Indicator Assembly, Top View

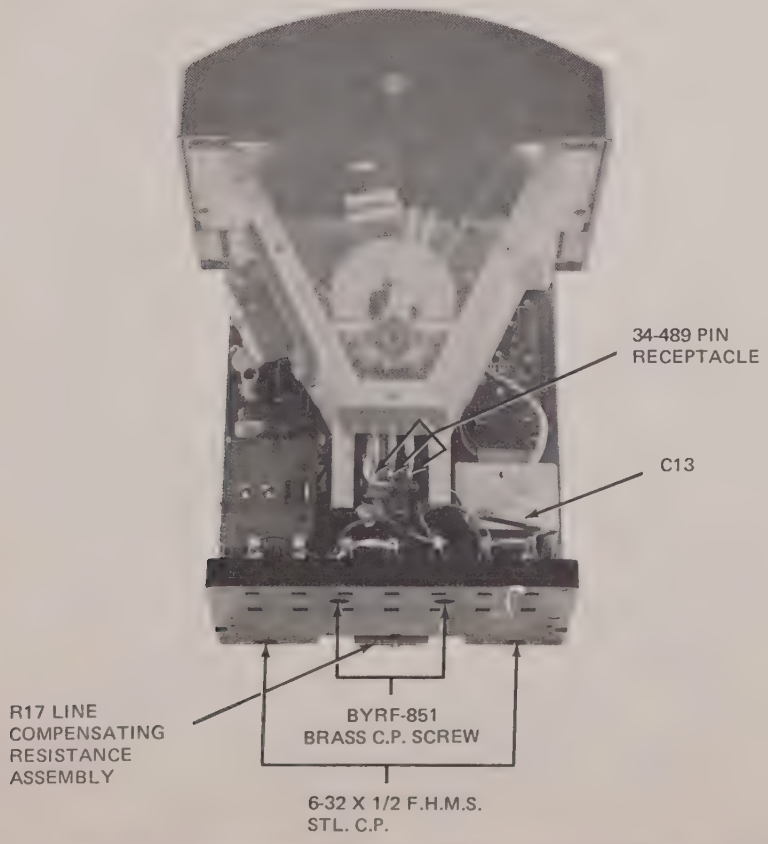


Figure 6-9. Replaceable Parts, Chassis Assembly, Top View (271P Chassis Shown)

A-7510 CHASSIS ASSEMBLY FOR 271P
INCLUDES 13-3664 CHASSIS AND A-7511
PCB ASSEMBLY

A-7296 CHASSIS ASSEMBLY FOR 272P
INCLUDES 13-3664 CHASSIS AND A-7323
PCB ASSEMBLY

A-9083 MOUNTING KIT IS INCLUDED WITH
REPLACEMENT CHASSIS ASSEMBLY

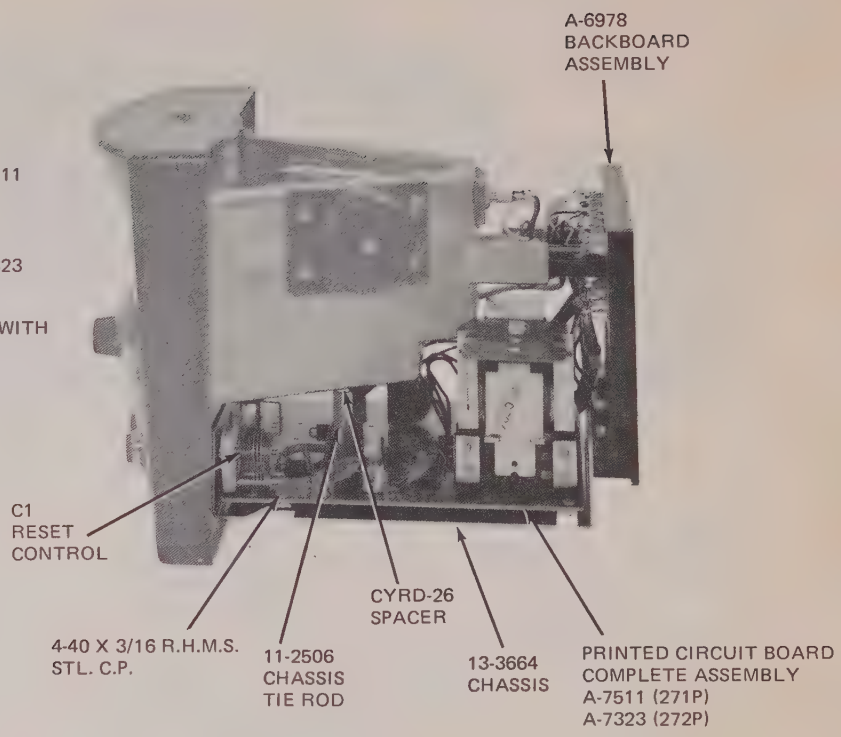


Figure 6-10. Replaceable Parts, Chassis Assembly, Side View (271P Chassis Shown)

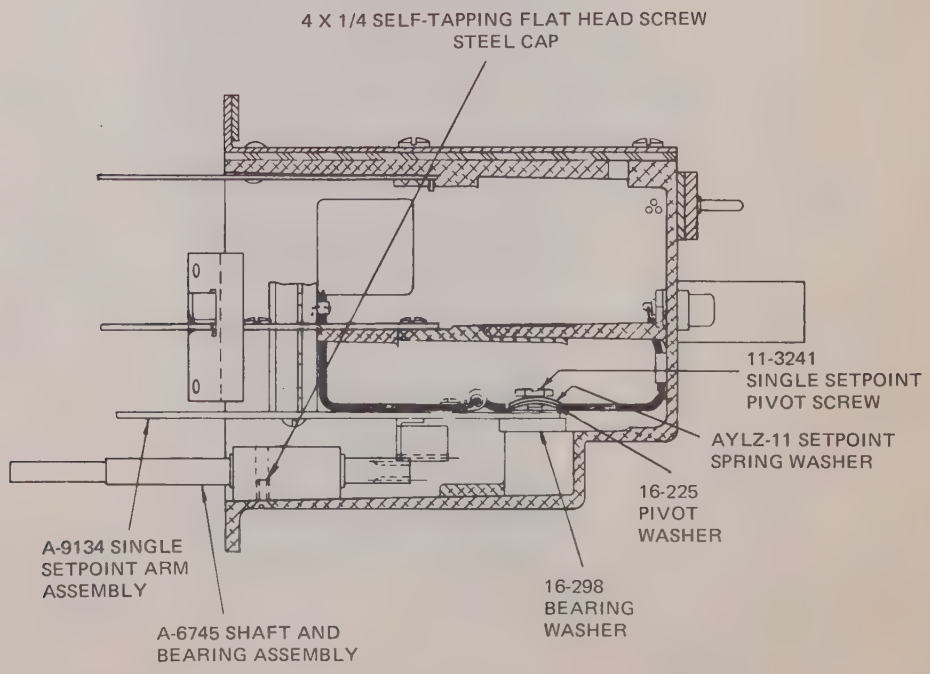


Figure 6-11. Replaceable Parts, Setpoint Mechanism

BIMETAL COMPENSATOR	
ANGULAR DEGREES COMPENSATED FOR*	PART NUMBER
1.5	18-069-1
3	18-070-1
4	18-061-1
5	18-062-1
6	18-071-1
7	18-072-1
8	18-064-1
9	18-066-1
10	18-065-1
11	18-074-1
12	18-075-1
13	18-076-1

*Depends on instrument temperature span and thermocouple.

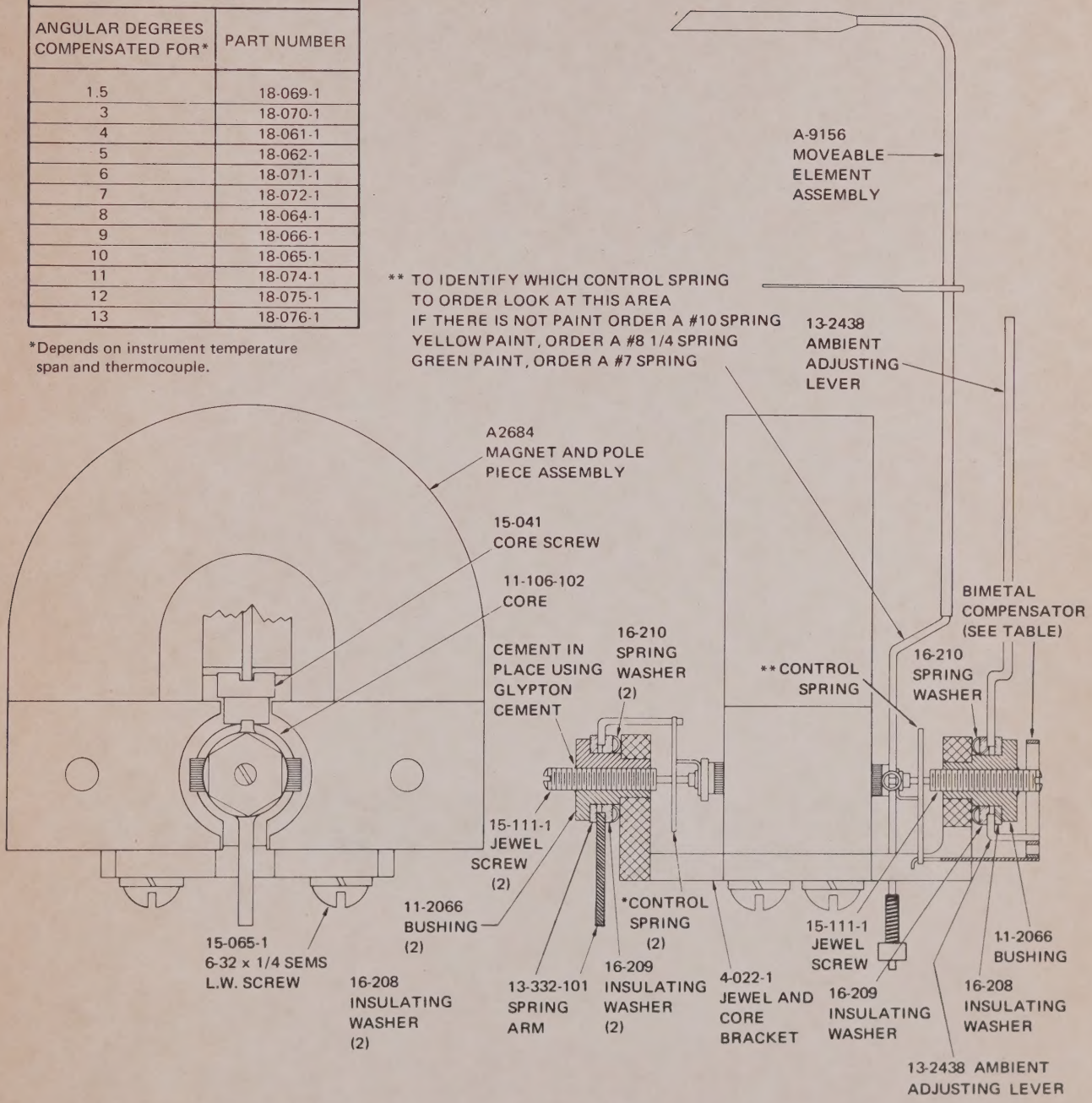


Figure 6-12. Replaceable Parts, Meter Movement Assembly A-9162

THE INSTRUCTIONS GIVEN HEREIN COVER THE DESCRIPTION, INSTALLATION, OPERATION AND MAINTENANCE OF SUBJECT EQUIPMENT. BARBER-COLMAN RESERVES THE RIGHT TO MAKE ENGINEERING REFINEMENTS THAT MAY NOT BE REFLECTED IN THIS BULLETIN.

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